

CSL PEST RISK ANALYSIS FOR *Milviscutulus mangiferae*

Summary

Milviscutulus mangiferae is a non-native, polyphagous scale pest of exotic ornamental plants, of low risk to the UK and moderate risk to the EU as a whole.

The pest has been intercepted coming into the UK on numerous occasions, most recently on plants for the vivarium industry. It presents a low risk to the UK, but does have the potential to cause a moderate amount of damage to ornamentals, particularly on specialist nurseries. In the southern areas of the EU the pest is likely to cause more damage due to the larger range of hosts growing outside. The small but growing mango industry of Spain is particularly at risk. There are chemical treatments available for the control and eradication of *M. mangiferae* on terrestrial plants, but recent UK interceptions have been made on plants linked with aquariums and for these there are no available control measures other than destruction.

STAGE 1: PRA INITIATION

1. What is the name of the pest?

Milviscutulus mangiferae (Green)

Hemiptera: Coccidae.
mango shield scale or mango soft scale

There are many synonyms of this pest, see Table 1 below. The major synonyms used in the literature are *Protopulvinaria mangiferae* and *Coccus mangiferae*.

Table 1: Synonyms

Protopulvinaria mangiferae (Green)	*Protopulvinaria kuraruensis* (Takahashi)
Coccus mangiferae (Green)	*Protopulvinaria wardi* (Newstead)
Coccus kuaruensis Takahashi	*Lecanium psidii* Green
Lecanium wardi Newstead	*Saissetia psidii*
Lecanium mangiferae Green	*Lecanium desolatum* Green
Coccus ixorae	*Coccus desolatum*
Protopulvinaria ixorae (Green)	*Kilifia mangiferae*
Coccus wardi	*Udinia psidii*
Lecanium ixorae Green	*Ptoropulvinaria mangiferae*: misspelling of genus name

(ScaleNet, 2008; CABI Arthropod Name Index, 1996)

2. What is the pest's status in the Plant Health Directive (Council Directive 2000/29/EC[1])?
This pest is not listed in the EC Plant Health Directive.

3. What is the recommended quarantine status of the pest in the lists of the European and Mediterranean Plant Protection Organisation (EPPO[2])?

EPPO List:	A1 regulated pest list		A2 regulated pest list		Action list		Alert list	

This pest is not listed as a quarantine pest by EPPO.

4. What is the reason for the PRA?
Milviscutulus mangiferae is absent from the UK and the EU. It has been intercepted in the UK on numerous occasions on imported cut flowers, ornamentals and aquatic plants. The vast majority of interceptions recorded since 1996 come from Singapore, but the pest has also been found on plant material from Costa Rica, Brazil, Ghana, South Africa, Thailand and Malaysia.

Between November 2005 and the end of 2007 there were fifteen separate identifications of this pest on ornamental plants entering the UK from Singapore. These were intercepted at the Live Fish Border Inspection Post at Hounslow in London (CSL, unpublished data). In the last three years there have been 165 invertebrate pests diagnosed on plants imported from Singapore and examined by the PHSI at Live Fish Border Inspection Posts. This compares with 158 on aquatic plants imported from Singapore between 1975 and 1995 (CSL, unpublished data) and suggests a change on the aquatic plant pathway into the UK and possibly a new pathway in the form of pests entering through the Live Fish Border Inspection Posts. It is this change that has initiated this PRA.

5. What is the PRA area?
The PRA area considered is the EU, with special reference to the UK due to the recent interceptions, but excludes locations such as the French Doms., Spanish Canary Islands and Portuguese Azores and Madeira.

STAGE 2: PEST RISK ASSESSMENT

6. What is the pest's present geographical distribution?
Milviscutulus mangiferae has a wide distribution, particularly in the Pacific and Caribbean areas, but is not known to have established in Europe, despite numerous UK interceptions. It is established in Israel.

Table 2 lists the current geographic distribution of *M. mangiferae*.

[1] http://europa.eu.int/eur-lex/en/consleg/pdf/2000/en_2000L0029_do_001.pdf

[2] http://www.eppo.org

Table 2: Geographic Distribution of *Milviscutulus mangiferae*	
North America:	USA (Florida, Hawaii, Texas)
South America:	Brazil, Colombia, Ecuador, Guyana, Venezuela
Central America and Caribbean.	Antigua and Barbuda, Barbados, Costa Rica, Cuba, Dominican Republic, El Salvador, Grenada, Honduras, Jamaica, Martinique, Mexico, Nicaragua, Panama, Puerto Rico and Vieques Island, Saint Croix, St Lucia, U.S. Virgin Islands.
Europe:	No records – assume absent.
Africa:	Agalega islands, Côte d'Ivoire, Comoros, Ghana, Kenya, Madagascar, Mauritius, Rodriques Island, Reunion Island, Seychelles, South Africa, Tanzania, Zanzibar
Asia:	Bangladesh, China (Hong Kong), Indonesia, India, Israel, Japan, Malaysia, Pakistan, Philippines, Ryukyu Islands, Singapore, Sri Lanka, Thailand, Taiwan, Vietnam
Oceania:	Australia (North Queensland), Fiji, Palau, Papua New Guinea, Solomon Islands, Tonga, Western Samoa

References: Dash, 1916 (Barbados); Grimshaw & Donaldson, 2007 (Australia); Anon., 1917 (Grenada); Watts, 1916 (St Lucia). ScaleNet, 2008 (all other records).

7. Is the pest established or transient[3] in the PRA area?

No, this pest is not considered established or transient in the EU.

8. Is there any reason to suspect that the pest is already established in the PRA area?

This scale insect has been intercepted in the UK on numerous occasions and on at least one of these an infested consignment was not held while the pest was being identified (CSL, unpublished data). It is possible, therefore, that there may be isolated populations of this pest in private homes on houseplants or in aquariums and terrariums. There are no known records of its interception elsewhere in the EU (EUROPHYT - CIRCA, 2008; EUROPHYT - PHY, 2008).

9. What are the pest's host plants?

Milviscutulus mangiferae is a highly polyphagous pest. Records from ScaleNet (2008) name host plants from 67 genera in 40 families, but the entry into the UK on two additional plant genera, one from an additional family, suggests that no comprehensive host list exists (CSL, unpublished data). Known hosts include economically important crops, such as mangoes (*Mangifera indica*), nutmeg (*Myristica fragrans*), breadfruit (*Artocarpus altilis*) (all of which are noted as a major hosts (CABI CPC, 2008)), avocados (*Persea americana*), cloves (*Syzygium aromaticum*), oranges (*Citrus sinensis*) and lemons (*Citrus limon*), as well as ornamentals such as *Cordyline*, *Jasminium* and *Hibiscus spp.* (ScaleNet, 2008).

10. What hosts are of economic and/or environmental importance in the PRA area?

There are a number of host genera grown commercially in the EU, including *Citrus*, *Ficus*, *Mangifera* (mangoes) and *Persea* (avocado) (Re:fresh Directory, 2007). All of these are grown around the Mediterranean. Mangoes have been documented as the host that suffers the most severe attacks from

[3] Transience: presence of a pest that is not expected to lead to establishment (ISPM 5)

M. mangiferae (Avidov & Zaitzov, 1960) and are grown in Spain for marketing in France as well as local consumption (Saúco & Massip, 2004). Avocados are grown across the Mediterranean, with one third of EU consumption being produced by Spain, mainly for Spanish and French markets (Saúco & Massip, 2004). Avocados may be severely attacked by *M. mangiferae*, but populations do not reach the levels seen on mangoes (Avidov & Zaitzov, 1960). More economically important to the EU are *Citrus* crops, such as oranges and lemons, but, although known to be hosts for *M. mangiferae*, in Israel these trees are recorded as only being attacked sporadically and there is no evidence of the trees suffering from these attacks (Avidov & Zaitzov, 1960).

As well as these commodity crops, other host genera are important amenity and garden/patio plants in the EU, some of which (e.g. *Cordyline*) have also become naturalised. While there is little data on the scales effect on ornamentals it has been recorded heavily infesting Java plums or Jambolans (*Syzygium cumini*) in a park in Israel, with the trees suffering reduced growth and fruit setting (Avidov & Zaitzov, 1960; Gerson, 1975). In addition to occurring in southern Europe, some ornamental/ amenity hosts may be found further north, including in milder parts of the UK e.g. in urban heat islands and the mild southwest (Preston *et al.*, 2002).

Away from the Mediterranean area of the EU the majority of the potential hosts of *M. mangiferae* are most commonly found in glasshouses, as conservatory or houseplants or may be used in vivariums. The value of such plants varies greatly depending on size or end use. *Ophiopogon japonicus* is an ornamental plant often sold for terrariums or freshwater aquaria. These may retail for just a few pounds (Life Force Pet and Garden, 2008). At the opposite end of the scale *Dracaena marginata* is a popular pot plant for offices as it will tolerate irregular watering. Large plants may retail for up to £95 (House of Plants, 2008). Both of these are species on which *M. mangiferae* has been intercepted coming into the UK.

11. If the pest needs a vector, is it present in the PRA area?

No vector is required. This is a free-living organism.

12. Describe the pathway(s) considered by this PRA[4].

The UK imports mangoes and avocados from all over the world (Re:fresh Directory, 2007). *M. mangiferae* has been intercepted once on mango fruit (from Brazil), but the scale does not actually attack the fruit itself and all other interceptions with plant material recorded since 1996 have been made on leaves or whole plants (CSL, unpublished data). This suggests that the most likely entry route of *M. mangiferae* into the EU is on imported plants rather than produce.

Israel's flower and ornamental plant business is huge and makes up a third of the countries total fresh agricultural exports. Israel is the geographically closest location to the EU in which *Milviscutulus mangiferae* is established and their export business is reported to account for 60% of sales of flower auctions in Western Europe (The Guardian, AGROCARE, 2005). *M. mangiferae* has been reported on ornamental trees in parks in Israel (Gerson,

[4] A pathway description would typically identify a geographic origin, a host and what the intended use of the host is.

1975) and is known to infest many ornamentals (Wysoki *et al.*, 1993). However, despite the potential for transfer to the EU through the ornamental plant industry there have been relatively few interceptions in the UK on none vivarium plants and none at all from Israel (CSL, unpublished data). There are no known interceptions of *Milviscutulus mangiferae* in other areas of the EU.

This PRA focuses on one particular trade route through which there have been multiple interceptions. In the UK, since the end of 2005, all plants infested with *M. mangiferae* have come from Singapore via the Live Fish Border Inspection Post. It is not known if all plants have come from the same supplier, but as well as *M. mangiferae,* many have also been infested with non-European *Bemisia tabaci*, which are EU quarantine pests listed in Annex IAI of the EU Plant Health Directive. The plants intercepted (*Cordyline*, *Dracaena* and *Ophiopogon spp*.) are all popular ornamental house and office plants and in this case seem to have been intended for aquarium or terrarium use.

13. How likely is the pest to enter the PRA area[5]?

Very unlikely		Unlikely		Moderately likely		Likely		Very likely	✓

Milviscutulus mangiferae has entered the UK on numerous occasions, largely since 2005 on imports of plants for the aquarium / houseplant trade from Singapore. Unless this pathway was to change or become more closely regulated it is very likely the pest will continue to enter the UK, already in association with suitable hosts. There are no known interceptions in other areas of the EU and while other pathways on ornamental plants are possible these recurring importations pose the greatest risk.

14. How likely is the pest to establish outdoors in the PRA area?

Very unlikely		Unlikely		Moderately likely		Likely	✓	Very likely	

A Korean laboratory study showed the threshold temperature and thermal constants for the development of one generation of *M. mangiferae* to be 11.7°C and 1,000 day degrees respectively (Kim, 1997). Average monthly maximum and minimum temperatures from Tel Aviv, Israel; Santa Cruz De Tenerife, the Canary Islands; Seville, Spain and London, UK have been used to give an approximation of the number of degree-days above this threshold temperature in these regions (see Appendix 1). In Tel Aviv, the average temperature gives just over 3,100 cumulative degree-days, accounting for the reported three generations a year (Avidov & Zaitzov, 1960), although the average daily minimum will only exceed the threshold for 8 months of the year (World Weather Information Service (2008) 1980 - 1999 data) and the mortality rate of the first (winter) generation is quite high (85%), (Avidov & Zaitzov, 1960). In Tenerife, the average temperature is slightly higher than

[5] Pest entry includes an assessment of the likelihood of transfer to a suitable host (ISPM No. 11, FAO, Rome)

that in Israel and gives just over 3,400 cumulative degree-days, with the minimum daily temperature actually exceeding the 11.7°C threshold all year round (World Weather Information Service (2008) 1961-1990 data). In Seville, an area of Spain where both *Mangifera* and *Citrus* are grown, the average temperature gives just over 2,500 degree-days, possibly restricting the number of generations and the daily minimum temperature will exceed 11.7°C for six months of the year (World Weather Information Service (2008) 1971-2000 data). In London (an urban heat island) the cumulative total of degree-days comes to less than 700 and the average daily minimum temperature only exceeds 11.7°C for two months of the year (World Weather Information Service (2008) Current data). This suggests that in the UK the temperatures may not be high enough for one generation to develop outdoors.

The areas of the world in which *M. mangiferae* has become established are generally equatorial and humid or warm temperate, with hot and often humid summers. There are very few of it's known host genera established outside in the UK, and those that are tend to be in sheltered gardens or the warmer maritime areas, such as the southwest. Even these are likely to experience colder winters than those in the Coastal Plain of Israel. Based on this information, *M mangiferae* is unlikely to establish outdoors in northern Europe. Although temperature differences in mainland southern Europe compared to Israel may restrict the number of generations of *M. mangiferae* there is a higher likelihood of establishment in this part of the EU, with warmer winters and a greater proliferation of outdoor growing hosts. Within the area under consideration, the Mediterranean region including Spain, Italy and Greece is likely to be most at risk. The closely related species *Protopulvinaria pyriformis* is a known pest of avocado (De Meijer, *et al.*, 1989) and has established in Spain, France, Greece and Italy as well as Israel (ScaleNet, 2008).

Overall, *M. mangiferae* is considered likely to be able to establish outdoors in the Mediterranean region of the EU, but very unlikely to establish outdoors further north.

15. How likely is the pest to establish in protected environments in the PRA area?

Very unlikely		Unlikely		Moderately likely		Likely	✓	Very likely	

There are no known records of *Milviscutulus mangiferae* on plants under protection, but this may be due to its current distribution being such that its hosts would largely be grown outdoors. Scale insects in general establish very well in protected environments. The plant species on which *Milviscutulus mangiferae* has recently been intercepted in the UK are popular ornamental house and office plants and it is likely that this pest could survive in a protected environment, either under glass at a specialised nursery, where it may be able to spread to multiple hosts, or in the localised environment of a house or office as a pot, conservatory or vivarium plant. In the Canary Islands there are small areas of mangoes grown under glass for the early season market (Saúco & Massip, 2004) and it may be that other host crops are grown under protection in the Mediterranean.

16. How quickly could the pest spread[6] within the PRA area?

Very slowly		Slowly		Moderate pace	✓	Quickly		Very Quickly	

Natural dispersal is likely to be slow. Parthenogenesis is the dominant form of reproduction for these scale pests and males are seldom recorded. Adult females and older larvae of *M. mangiferae* are essentially sedentary and the adults die just after producing first-instar larvae. Only these early stage larvae, or crawlers, can migrate to any extent and it is their movement that disperses a population (Kasuya, 2000).

The main spread threat to and within the EU would be human intervention through the movement of infested plants around the PRA area and through the physical spread of the pest between different individual plants in a nursery, office or home. The current pathway, the UK import of aquarium and houseplants, limits the potential spread of this pest to localised areas.

In Israel the first records of *Milviscutulus mangiferae* were in 1948 and it has since become established in most mango-growing areas of the country (Wysoki *et al.*, 1993). There are up to three generations a year, but the mortality in the winter is quite high, with only 15% of the larvae that hatch succeeding in maturing and giving rise to a new generation. This rises to 25% in the spring and 50% in the summer (Avidov & Zaitzov, 1960). The speed at which this scale established itself across Israel suggests human intervention.

17. Which part of the PRA area is the endangered area?

Based on current knowledge of the biology and preferred environment of *M. mangiferae* it is considered very unlikely that this would survive outdoors in northern Europe (see 14). In southern Europe the likelihood of establishment outside is greater, and, although major commodity crops (such as *Citrus*) are unlikely to suffer from attacks, known hosts such as mangoes and avocados are grown commercially in the Mediterranean area.

At present the area of the EU most at risk is the ornamental horticulture industry as the pest is highly polyphagous, likely to find many hosts in a confined area and may be unwittingly spread widely around a glasshouse or polytunnel by nursery staff. In southern Europe there may be problems outdoors with amenity plants becoming affected.

18. What is the pest's economic, environmental or social impact within its existing distribution?

Very small		Small		Medium	✓	Large		Very large	

M. mangiferae is reported as a pest on mangoes in Florida (Berger, 1938), the Philippines (Otanes, 1936), Israel (Avidov & Zaitzov, 1960), Vietnam (Wysoki *et al.*, 1993) and South Africa (Kamburov, 1987), but is only mentioned as a serious economic pest in the latter three (Wysoki *et al.*, 1993). It is mentioned as being injurious to clove trees and coconuts (Dupont, 1923; Williams & Watson, 1990), and also avocado, guava, jambolan, jack fruit and rose apple,

[6] ISPM No 5. defines spread as the expansion of the geographic distribution of a pest within an area. Note that just because an organsim can move or be transported quickly, does not mean that it will spread quickly, i.e. it also has to establish.

though without populations reaching the same levels as on mangoes (Avidov & Zaitzov, 1960). Mango flowers attacked by this pest wither and fall and sooty moulds develop on leaves covered with honeydew from the scales (Otanes, 1936). Direct feeding on the leaves can lead to yellowing and, with large populations, premature leaf drop, failure of buds to open, reduced crop yields the following season and in extreme cases the death of branches and whole trees (Avidov & Zaitzov, 1960; Wysoki *et al.*, 1993). However, despite being an economic pest, in Israel chemical control is usually not required, unless the activity of natural enemies is impaired by spraying or traffic pollution (Wysoki *et al.*, 1993).

In Israel, the scale is also considered an urban pest, soiling cars with honeydew when they are parked underneath infested trees (Gerson, 1975).

19. What is the pest's potential to have economic, environmental or social impacts in the PRA area?

Very small		Small	✓	Medium		Large		Very large	

The level of damage caused by this pest has been quite well documented on mangoes, but not on any of its other known hosts. This may imply that the level of damage caused has not warranted further documentation. Avidov and Zaitzov (1960) listed a number of hosts which were known to have been severely attacked (including mangoes and, to a lesser extent, avocado) and another group of hosts only believed to be sporadically infested (including *Citrus*) implying that plants in the latter group may act as hosts, but do not suffer from the attacks. Within Europe, mangoes are only grown commercially in Spain. With around 1,400 ha being grown (which includes the area in the Spanish Canary Islands) (Saúco & Massip, 2004) mangoes are a small commercial crop, but one that seems to be increasing and, although the number of generations may be fewer than in Israel, *M. mangiferae* may become a minor pest in these areas.

The level of susceptibility of other hosts growing in the EU is unknown. The only documentation of *M. mangiferae* on ornamentals comes from Israel and complaints by residents in Tel-Aviv about the levels of honeydew dropping onto cars from trees planted in parks (Gerson, 1975). Assuming similar damage levels on ornamentals such as *Cordyline*, a large heavily infested ornamental plant in an office or home may become unsightly and potentially costly to replace. However, this cost would be minor compared to that incurred by a large specialist nursery or vivarium plant stockist if customers find problems with these plants and trade suffers. It is these specialists that could suffer the largest impact. Heavily infested amenity plants are likely to be more of a nuisance than an economic problem, as seen in Israel (Gerson, 1975), although in southern Europe they may provide a reservoir of pests that could affect commercial fruit crops (e.g. mango, avocado).

Overall the pests' potential to have economic impact has been rated as small, but it should be noted that a moderate impact is possible in mango growing regions of the EU. In other areas, where hosts plants are ornamental and largely amenity or individual home-based the impact is likely to be small, although a moderate impact may also occur at specialist nurseries.

20. What is the pest's potential as a vector of plant pathogens?
Milviscutulus mangiferae is not a known vector of plant pathogens.

STAGE 3: PEST RISK MANAGEMENT

21. If not already present in the PRA area, how likely is the pest to continue to be excluded from the PRA area?

	Very likely	Likely	Moderately likely	Unlikely	Very Unlikely
Outdoors:		✓			

The import of ornamental plants from areas where *M. mangiferae* is already established is the most likely entry route into the EU. To date the majority of recorded interceptions in the UK have been on plants imported for the aquarium or houseplant trade. The low numbers of potential hosts, and the climatic conditions compared to its present distribution, mean it is unlikely that *M. mangiferae* could establish outdoors in the UK - or other areas of northern Europe - and there are no known possible links with this particular import route and southern Europe. What is unknown is if other pathways connected with the mango growing industry, or the importation of ornamental plants, exist in southern Europe itself, particularly given the presence of the pest in Israel. On the basis of the current known pathway it is likely that the pest would continue to be excluded from the outdoors in the PRA area, but this may need to be revised based on any new pathways that are identified.

	Very likely	Likely	Moderately likely	Unlikely	Very Unlikely
In protection:				✓	

The import of ornamental plants poses a greater risk to plants under protection. Under protection the scales are more likely to survive in all areas of the EU and recent interceptions in the UK have all been on plants linked with the vivarium and indoor ornamental plant industry. The scales feed mainly on the underside of the leaf of a plant (Avidov & Zaitzov, 1960) and so the pest may not be immediately evident. Without a change in the pathway or its regulation it is unlikely that this pest may be excluded from ornamentals under protection.

22. If the pest enters or has entered the PRA area how likely are outbreaks to be eradicated?

Very likely	Likely	Moderately likely	Unlikely	Very unlikely
		✓		

There are no reports of this pest being completely eradicated, however based on current pathways, the most likely EU outbreaks would be localised and limited either to individual plants in homes or offices or specialist nurseries and stockists. This increases the chance of successfully achieving eradication, by either destruction of the affected plants or quarantine and/or

chemical treatment. Chemical options available in the UK include the active ingredients acetamiprid, buprofezin, deltamethrin, dodecylphenol ethoxylate, fatty acids and vegetable oil extracts / glucose polymer. In the case of recent imports the association with aquariums limits the insecticidal treatments available, due to the possibility that the infested plants will be used in vivariums where there are aquatic animals, even if the plants themselves are not fully submerged. This has led to either the destruction or re-export of the plants (CSL, unpublished data).

23. If eradication is not possible, what management options are available for containment and control?

In homes and offices chemical treatments and eradication are not usually practical, but control and containment to individual terrestrial plants or areas may be possible with the use of approved home and garden insecticides or physical washing.

Outdoor infestations on mango crops and amenity planting in southern Europe may be difficult to eradicate due to the number of potential hosts available acting as a reservoir for this pest. In many areas where the pest is established, however, chemical controls are not usually required, numbers being kept under control by the activity of natural enemies. These vary depending on the region in which *M. mangiferae* is found, but parasitoids of the genus *Coccophagus* have been found associated with the scale in the Philippines (Otanes, 1936), South Africa (Kamburov, 1987) and Israel (Avidov & Zaitzov, 1960). The fungus *Cephalosporium lecanii* is also widely reported to provide natural control, in Grenada (Anon., 1917), St Lucia (Watts, 1916), the Seychelles (Dupont, 1923) and Florida (Berger, 1938). The presence of specific natural enemies to this scale in EU member states is unknown, but species of *Coccophagus* are believed to be present in Europe, including in areas of the Mediterranean where the establishment of *M. mangiferae* outside would be most likely, and most damaging (Fauna Europaea, 2007). In areas of Israel where natural enemies have been affected by high levels of pollution, or where aerial bait sprays have been used, chemical controls are also necessary to reduce populations of *M. mangiferae* (Wysoki *et al.*, 1993). The encouragement of potential natural enemies may act alongside compatible chemical usage in keeping the scale populations under control / below unacceptable levels.

24. Conclusion

Milviscutulus mangiferae is a polyphagous tropical scale pest and, in terms of the EU, it poses a greater threat to plants in the southern Mediterranean region than northern Europe.

In the north, the scale is unlikely to establish outdoors, but may become established in ornamental nurseries or specialised aquarium/terrarium stockists. Damage to plants is likely to reduce their ornamental value and be of particular concern to nurseries and stockists where there are large numbers of potential hosts available. In southern Europe the temperatures and number of outdoor hosts increases. The scale is known to have a range of commodity crops as hosts, particularly mangoes,

which are grown in mainland Spain, and avocados, which are grown across the Mediterranean. Many ornamentals used in amenity planting may also be affected or act as reservoirs for this pest.
A new pathway has been identified with the import of vivarium plants from Singapore and although chemical treatments are available for terrestrial plants this is not the case for those intended for aquaria due to contamination of the water. To date the policy on interception in the UK has been the destruction of these plants and this would continue to be recommended due to the potential for establishment under protection. Further investigation into the pathway, discussion with the supplier regarding the requirement of plants to be free from non-native plant pests and consideration of possible alternative plant sources is also recommended, particularly with the plants also being carriers of *Bemisia tabaci*.

Further work that would reduce uncertainties

Area of PRA	Uncertainties	Further work that would reduce uncertainty
Taxonomy	None	
Pathway	Supplier of the infested plants found at the Live Fish Border Inspection Post: not certain if this was the same for all recent interceptions. Are plants imported from the same source elsewhere in the EU?	Investigation into the import history of the intercepted infested plants and imports from similar sources to the rest of the EU.
Distribution	None	
Establishment	Minimum temperature requirements for the scale to survive are unknown. Potential establishment levels under protection unknown.	Work on the effect of differing temperatures on the scale's survival and fecundity.
Spread	Aside from natural crawler dispersal and movement of plant material, what other means of dispersal are available to these scale insects?	Looking at the potential of wind, and bird dispersal of these insects.
Impact	What is the level of damage caused to ornamental hosts such as those intercepted in the UK?	Further investigation of damage on hosts other than mangoes.
Management	The lack of control measures for pests on aquatic plants has led to their destruction. Is this their end use?	Investigation into end use of this plants and possibility of treatment if a terrestrial end use is found/confirmed.

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Appendix 1: Original data from World Weather Information Service, 2008

ISRAEL, Tel Aviv		Temp threshold for development =	11.7	Data period 1980 - 1999				
		DD above threshold for a generation =	1000					
Month	Days (D)	Mean monthly temp. (Tmm)	Temp. threshold (To)	difference (Tmm-To)	(Tmm-To)(D)	Conditional degree days (DD>0)	Cumulative degree days	No. generations (DD/1000)
Apr	30	18.6	11.7	6.9	207.0	207.0	207.0	0.2
May	31	21.1	11.7	9.4	291.4	291.4	498.4	0.5
Jun	30	24.1	11.7	12.4	370.5	370.5	868.9	0.9
Jul	31	26.6	11.7	14.9	461.9	461.9	1330.8	1.3
Aug	31	27.0	11.7	15.3	472.8	472.8	1803.6	1.8
Sept	30	26.0	11.7	14.3	427.5	427.5	2231.1	2.2
Oct	31	23.2	11.7	11.5	356.5	356.5	2587.6	2.6
Nov	30	19.0	11.7	7.3	219.0	219.0	2806.6	2.8
Dec	31	15.2	11.7	3.5	108.5	108.5	2915.1	2.9
Jan	31	13.6	11.7	1.9	57.4	57.4	2972.4	3.0
Feb	28	13.8	11.7	2.1	57.4	57.4	3029.8	3.0
Mar	31	15.4	11.7	3.7	113.2	113.2	3143.0	3.1

CANARY ISLANDS, Santa Cruz De Tenerife		Temp threshold for development =	11.7	Data period 1961 - 1990				
		DD above threshold for a generation =	1000					
Month	Days (D)	Mean monthly temp. (Tmm)	Temp. threshold (To)	difference (Tmm-To)	(Tmm-To)(D)	Conditional degree days (DD>0)	Cumulative degree days	No. generations (DD/1000)
Apr	30	19.1	11.7	7.4	222.0	222.0	222.0	0.2
May	31	20.5	11.7	8.8	272.8	272.8	494.8	0.5
Jun	30	22.2	11.7	10.5	313.5	313.5	808.3	0.8
Jul	31	24.6	11.7	12.9	398.4	398.4	1206.7	1.2
Aug	31	25.1	11.7	13.4	413.9	413.9	1620.5	1.6
Sept	30	24.4	11.7	12.7	381.0	381.0	2001.5	2.0
Oct	31	22.9	11.7	11.2	347.2	347.2	2348.7	2.3
Nov	30	20.8	11.7	9.1	271.5	271.5	2620.2	2.6
Dec	31	18.8	11.7	7.1	218.6	218.6	2838.8	2.8
Jan	31	18.0	11.7	6.3	193.8	193.8	3032.5	3.0
Feb	28	18.0	11.7	6.3	176.4	176.4	3208.9	3.2
Mar	31	18.7	11.7	7.0	215.5	215.5	3424.4	3.4

SPAIN, Seville		Temp threshold for development =	11.7	Data period 1971 - 2000				
		DD above threshold for a generation =	1000					
Month	Days (D)	Mean monthly temp. (Tmm)	Temp. threshold (To)	difference (Tmm-To)	(Tmm-To)(D)	Conditional degree days (DD>0)	Cumulative degree days	No. generations (DD/1000)
Apr	30	10.6	11.7	-1.2	-34.5	0.0	0.0	0.0
May	31	12.3	11.7	0.6	18.6	18.6	18.6	0.0
Jun	30	14.7	11.7	3.0	90.0	90.0	108.6	0.1
Jul	31	16.4	11.7	4.7	145.7	145.7	254.3	0.3
Aug	31	19.8	11.7	8.1	249.6	249.6	503.9	0.5
Sept	30	23.9	11.7	12.2	364.5	364.5	868.4	0.9
Oct	31	27.4	11.7	15.7	485.2	485.2	1353.5	1.4
Nov	30	27.3	11.7	15.6	466.5	466.5	1820.0	1.8
Dec	31	24.6	11.7	12.9	398.4	398.4	2218.4	2.2
Jan	31	19.6	11.7	7.9	243.4	243.4	2461.7	2.5
Feb	28	14.7	11.7	3.0	84.0	84.0	2545.7	2.5
Mar	31	11.8	11.7	0.1	1.6	1.6	2547.3	2.5

UK, London		Temp threshold for development =	11.7	Current data				
		DD above threshold for a generation =	1000					
Month	Days (D)	Mean monthly temp. (Tmm)	Temp. threshold (To)	difference (Tmm-To)	(Tmm-To)(D)	Conditional degree days (DD>0)	Cumulative degree days	No. generations (DD/1000)
Apr	30	4.8	11.7	-6.9	-207.0	0.0	0.0	0.0
May	31	5.1	11.7	-6.7	-206.2	0.0	0.0	0.0
Jun	30	7.1	11.7	-4.7	-139.5	0.0	0.0	0.0
Jul	31	9.3	11.7	-2.4	-74.4	0.0	0.0	0.0
Aug	31	12.9	11.7	1.2	35.7	35.7	35.7	0.0
Sept	30	16.0	11.7	4.3	127.5	127.5	163.2	0.2
Oct	31	18.0	11.7	6.3	195.3	195.3	358.5	0.4
Nov	30	17.7	11.7	6.0	178.5	178.5	537.0	0.5
Dec	31	15.3	11.7	3.6	110.1	110.1	647.0	0.6
Jan	31	12.1	11.7	0.4	10.9	10.9	657.9	0.7
Feb	28	7.8	11.7	-4.0	-110.6	0.0	657.9	0.7
Mar	31	5.8	11.7	-5.9	-182.9	0.0	657.9	0.7